Method and device for determining the position of rotationally drivable tools

The present invention relates to the measurement of
5   rotationally drivable tools and in particular the
determination of the position of a rotationally drivable
tool in a machine tool.

To determine the position of a rotating tool in machine
10 tools for machining, it is known to use light barriers and
in particular laser light barriers. During this procedure,
the tool to be measured is moved in the direction towards
the measuring beam, the moment at which the tool interrupts
the measuring beam being used to calculate the position of
15 the tool in the machine tool. When the measuring beam is
interrupted, the light barrier outputs a signal indicating
the moment of the beam interruption to a control system of
the machine tool. At the moment of the beam interruption,
the current axis positions of the machine tool are detected
20 by its control system and, using a calibration assigned to
the tool concerned, are used to determine the current
position of the tool.

A disadvantage of this procedure is that it is not possible
25 to distinguish between interruptions of the measuring beam
on account of the tool and beams interruptions on account
of particles present in the region of the tool (e.g. drops
of coolant, flying chips, splashes of lubricant, etc.).
This may lead to inaccurate or incorrect measurements with
30 no longer tolerable uncertainties and even termination of
the measuring operation and stoppage of the machine.

The object of the present invention is to provide a
solution to avoid the interfering influences of (air-
contaminating) particles situated in the region of a
rotationally drivable tool to be measured when determining
5   the position of the tool in a machine tool.

To achieve this object, the present invention provides a
method and device in which the moment of separation of a
tool to be measured and a measuring beam is used to
10 determine the position of the tool.

The present invention serves for determining the position
of rotationally drivable tools in machine tools for
machining (e.g. turning, planing, milling, drilling/boring,
15 countersinking/counterboring, reaming, grinding, eroding
and the like).

In the method according to the invention for determining
the position of a rotationally drivable tool, the latter is
20 positioned in a measuring beam in such a manner that the
beam path of the latter is interrupted. Hereinbelow, the
interruption of the measuring beam by the tool is
understood to mean a state in which the tool at least
partially shades the measuring beam. A definition of this
25 may be, for example, that an interruption of the measuring
beam exists when the measuring beam is completely blocked
by the tool or an amount of light energy which exceeds a
predetermined limit value is let through. Such a limit
value may be defined, for example, in dependence on the
30 amount of light energy which is at least required to output
a signal by means of a receiver which is used for the
measuring beam and indicates the reception of the measuring
beam. For example, an interruption may exist when a partial

shading of the measuring beam by the tool leads to an
amount of light energy let through equal to 50% of the
amount of light energy emitted.

5   To define this starting position, the known, approximate
measurements of the tool to be measured can be used. This
positioning can also be achieved by the tool being moved,
by activating single or plural axes of the machine tool, in
the manner of a searching movement until the tool is
10 situated in the measuring beam. During or after this, the
tool is rotated.

In addition, a movement direction for determining the
position is chosen. This may, for example, be the axial
15 direction of a drill to be measured, or the direction of a
radius if a milling cutter is to be measured.

After this, the tool is moved relative to the measuring
beam, at a chosen velocity which is as constant as
20 possible, in a direction away from it, i.e. a movement of
the tool in the chosen movement direction is effected.
During this, the tool is moved to a position, referred to
as the measuring position hereinbelow, in which the beam
path of the measuring beam is no longer interrupted by the
25 tool, i.e. the tool is separated from the measuring beam.
The moment of separation is reached when the interruption
of the measuring beam by the tool leads to a (partial)
shading in which the amount of light energy let through is
sufficient to trigger a signal of the receiver. This amount
30 of light energy may be defined as in the above positioning
of the tool in the measuring beam or may differ from this.

The measuring position is detected, for example using axis positions determined by a control system of a machine tool, and used to determine a position for the tool. The measuring position, i.e. the moment of separation, is

5   detected when the measuring beam is not interrupted for at least one revolution of the tool.

In order to determine the tool position from the measuring position, the position of the measuring beam relative to

10   the machine tool and the tool, quantities of a (previously performed) calibration for the machine tool and the measuring beam, is employed.

Preferably, the tool is initially positioned in the

15   measuring beam in such a manner that the beam path of the latter is interrupted permanently, periodically, at predetermined instants or at predetermined time intervals.

Preferably, the tool is rotated at a rotational speed which

20   is relatively high in relation to the movement velocity in order to minimise the measuring error when detecting the moment of separation of tool and measuring beam on account of the tool rotation. In this regard, it is possible to correct the measuring error in dependence on the measuring

25   speed for the measuring beam and the delay time which results from the rotational speed and the movement velocity of the tool.

Furthermore, the determined position of the tool can be

30   used to calculate its geometry.

Exemplary embodiments of the invention are described below with reference to the appended figures, in which:

Fig. 1   shows schematic illustrations of a measuring
            arrangement for determining the position of a
            rotationally drivable tool using a measuring
5   beam, and

Figs. 2 to 5   show schematic illustrations of the
               implementation of the method according to
               the invention.
10

As sketched in Fig. 1, a measuring device having a
transmitter 10 and a receiver 12 is used to determine the
position of a rotationally drivable tool denoted as a whole
by 14, and in particular its region 16 to be used for
15 machining, in a machine tool (not illustrated). The
measuring device includes a light barrier with a measuring
beam 18, which is a light beam with collimated beam path or
a laser beam.

20 The region 16 of the tool 14 is moved, according to Fig. 2,
in the direction of the arrow illustrated therein towards
the measuring beam 18 until the latter is interrupted,
according to Fig. 3, by the region 16. Accordingly, the
receiver 12 outputs a signal indicating the interruption of
25 the measuring beam 18.

At this instant at the latest, the tool 14 is rotated and
moved away from the measuring beam 18, for example at a
rotational speed which is preset, constant and as high as
30 possible and/or a velocity which is preset, constant and as
low as possible. This movement chosen for determining the
position can, as illustrated in Fig. 4, be effected
opposite the direction of movement according to Fig. 2,

i.e. in the direction of the arrow shown in Fig. 4, or in the opposite direction. During this procedure, the tool 14 is moved away from the measuring beam 18 in such a manner that the measuring beam 18, seen in relative terms, moves

5   to a region of the machining region 16 which is suitable for determining the position of the tool 14.

When, as illustrated in Fig. 5, the tool 14 is separated from the measuring beam 18, i.e. the instant substantially

10 immediately after the interruption of the measuring beam 18 by the machining region 16 has ended, the receiver 12 generates a corresponding signal, upon which the axis positions of the machine tool are detected. In particular, the moment of separation of the tool 14 and the measuring

15 beam 18 is defined as the moment at which the measuring beam 18 is for the first time no longer interrupted for a complete revolution of the tool 14.

Accordingly, the instant at which the axis positions of the

20 machine tool are detected is delayed by a period of time which depends on the duration of a complete revolution of a tool 14 and the movement velocity. In order to compensate for this influence on the accuracy of the determination of the position of the tool 14, a correction factor is

25 calculated from the rotational speed and the movement velocity of the tool 14. Furthermore, the delay times which are caused by the individual components of the measuring device, result during the processing of signals of the measuring device and occur during the determination of the

30 axis positions are taken into account in the correction. In order to minimise the influence of the tool rotation and movement on the measuring result, a high rotational speed in comparison with the movement velocity is advantageous.